

# The Subseasonal Experiment (SubX)

Emerson LaJoie

CDPW

October 24, 2018

---

## Outline:

- ✓ Overview of the SubX project
- ✓ A week in the life of a hindcast
- ✓ Review verification metrics
- ✓ Show seasonal RPSS results for 2m temperature and precipitation from the SubXMME



**MAPP**  
Modeling, Analysis,  
Predictions, and Projections



## CORE TEAM

Ben Kirtman  
Kathy Pegion  
Tim DelSole  
Michael Tippett  
Andy Robertson  
Michael Bell  
Robert Burgman  
Jon Gottschalck  
Dan Collins  
Emerson LaJoie  
Hai Lin

## ECCC-GEM

Hai Lin  
Bertrand Denis

## SUBX TEAM

### NCEP-CFSv2

Dan Collins  
Jon Gottschalck  
Emerson LaJoie  
Emily Becker

### NCEP-GEFS

Yuejian Zhu  
Wei Li  
Eric Sinsky

### NASA-GEOS5

Deepthi Achuthavarier  
Randy Koster  
Len Marshak

### Navy-ESM

Neil Barton  
Joe Metzger

### NCAR-CCSM4

Ben Kirtman  
Duguong Min  
Kathy Pegion  
Rong Fu

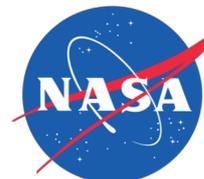
### ESRL-FIM

Shan Sun  
Stan Benjamin  
Ben Green

*Coming Soon ... NCAR-CESM46L-CAM5 and NCAR-CESM30L-CAM5...*



**MAPP**  
Modeling, Analysis,  
Predictions, and Projections



# SubX BY THE NUMBERS

**7** Global Models

**1+** Years of *Real-time*  
Forecasts

**17** Years of  
*Retrospective* Forecasts

**3-4** week guidance  
for Climate Prediction  
Center Outlooks

# SubX Protocol

- Prediction System Details up to Provider
- Real-time and Retrospective Systems Identical
- Reforecast Period: 1999-2015
- At Least 3 Ensemble Members
- Minimum Length: 32 Days
- Real-time Forecast Made Available to CPC  
*Every Thurs by 6am of Every week*
- Data on Uniform 1x1 Grid

# What is SubX?

*NOAA/Climate Testbed project focused  
on subseasonal predictability and predictions*

## **Objectives**

- Collecting and serving data both internally at CPC for use by operational forecasters and for the external community via the IRI data library
- Providing a baseline verification particularly for the weeks 3-4 temperature and precipitation probability forecasts
- Evaluating the skill of individual model systems
- Investigating multi-model combinations including selecting suitable models, optimizing the design of the system, and evaluation of the prediction products
- Enhancing communications between operational forecasts and the model forecast producers
- Participation in the NOAA/MAPP S2S Task Force

## Priority 1 Variables – Required to Support Operations

On 500 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Geopotential Height	geopotential_height	zg	m	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>

On 850 and 200 hPa levels

Variable	CF Standard Name	Abbrev	Unit	Frequency
Zonal Velocity	eastward_wind	ua	ms-1	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>
Meridional Velocity	northward_wind	va	ms-1	<a href="#">Average of Instantaneous values at 0,6,12,18Z</a>

On a single level

Variable	CF Standard Name	Abbrev	Unit	Frequency
2m Temperature	air_temperature	tas	K	<a href="#">Daily Average</a>
Precipitation	precipitation_flux	pr	kgm-2s-1	<a href="#">Accumulated every 24hrs</a>
Surface Temperature (SST+Land)	surface_temperature	ts	K	<a href="#">Daily Average</a>
Outgoing Longwave Radiation at top of Atm	toa_outgoing_longwave_flux	rlut	Wm-2	<a href="#">Accumulated every 24hrs</a>

# SubX Current Status

- ✓ Re-forecast & real-time forecast database
  - ✓ CPC
- ✓ Real-time forecast maps – **60+ weeks**
  - ✓ Weekly web page to support operations
- ✓ **Hindcast Skill Scores**
  - ✓ **Ranked Probability Skill Score**
  - ✓ **Brier Skill Score**
  - ✓ **Heidke Skill Score**
  - ✓ **Anomaly Correlation Coefficient**
  - ✓ **Weighted, Real-time equivalent**

<b>Week of Hindcast Dates and Target Dates</b>	Jan 2	Jan 3	Jan 4	Jan 5	Jan 6	Jan 7	Jan 8	Jan 9 Forecast Day	<b>Week 3-4 Outlook: Jan 24 – Feb 06</b>	
<b>Day of the week and Days to Target Dates</b>	Fri 22:35	Sat 21:34	Sun 20:33	Mon 19:32	Tues 18:31	Wed 17:30	Thurs 16:29	Fri 15:28	<b>2 weeks: Sat + 13 days (Fri) → WK34</b>	
<b>Center-Model  ----- Forecast Grab Period ----- </b>										
ECCC-GEM 4 members 32 days								Forecast Day		
EMC-GEFS 11 members 35 days								Forecast Day		
ESRL-FIMv2 4 members 32 days								Forecast Day		
NASA-GEOS 4 members 45 days								Forecast Day		
NCEP-CFSv2 4 members 44 days								Forecast Day		
NRL-NESM 4 lagged members 45 days								Forecast Day		
RSMAS-CCSM4 3 members 45 days								Forecast Day		
<i>Coming Soon:</i> CESM-46LCAM5 10 members 45 days								Forecast Day		<b><i>*Note: Each week the wk34 reforecast is scored and those scores are collected over a selected period</i></b>
CESM-30LCAM5 10 members 45 days								Forecast Day		

# Adjusted RPSS

- **RPSS:** *What is the relative improvement of the probability forecast over climatology in predicting the category that the observations fell into?*
- **Adjusted RPSS:** *This approach is motivated from the notion that an ensemble prediction system that produces better than random forecasts may nevertheless yield negative RPSS values if the ensemble size is small and climatology is chosen as a reference strategy. **This adjustment reduces the overall dependency on ensemble size.***
- **Perfect score: 1**

# Adjusted RPSS

$$RPSS_D = 1 - \frac{RPS_m}{RPS_{Cl} + D}$$

Where:

$m$  = ensemble members

$Cl$  = denotes the conventional climatological reference score

$K$  = number of categories

$c$  = observed climatology

and

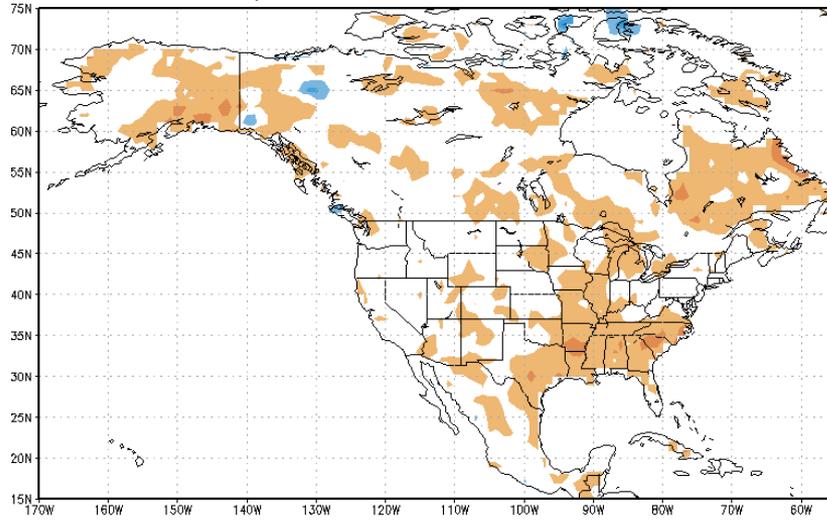
$$D = \frac{1}{m} \sum_{k=1}^K \sum_{l=1}^k \left[ c_l \left( 1 - c_l - 2 \sum_{i=l+1}^k c_i \right) \right]$$

If the  $K$  forecast categories are equiprobable, the correction term  $D$  simplifies to

$$D = \left( K^2 - 1 \right) / \left( 6Km \right)$$

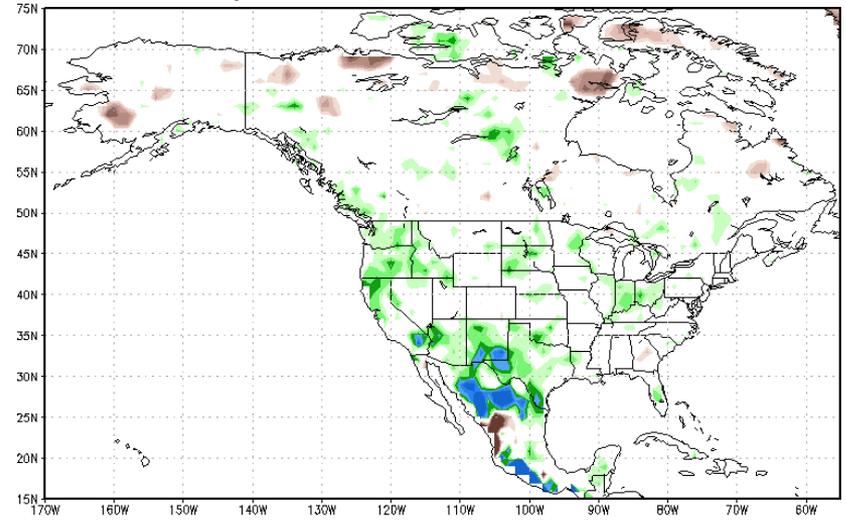
# Winter

adjRPSS-DJF TAS 7-MME for NA



GRADS: COLA/IGES

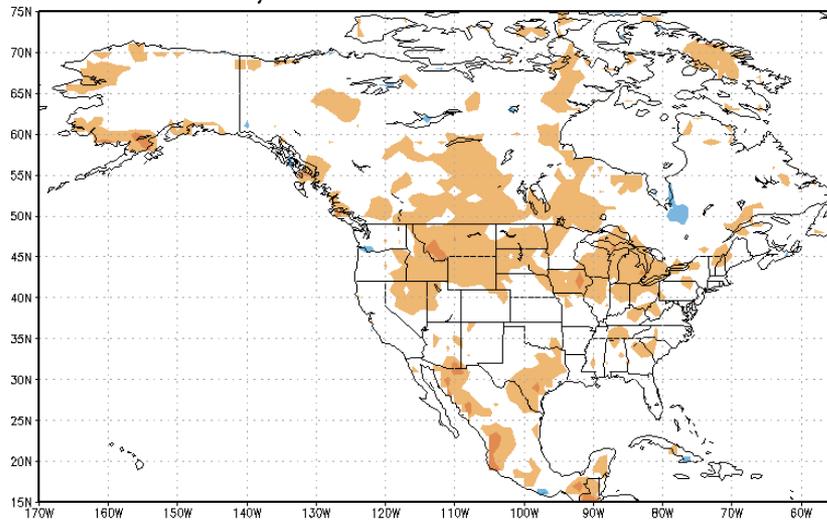
adjRPSS-DJF PR SFC 7-MME for NA



GRADS: COLA/IGES

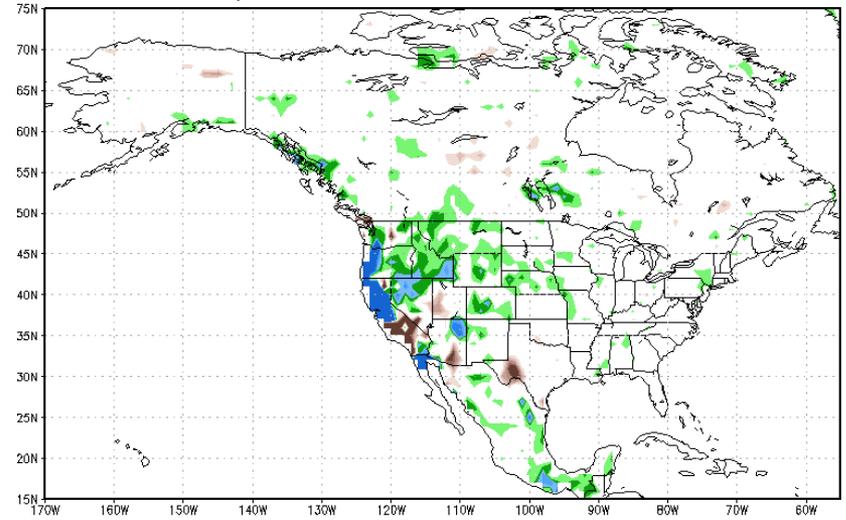
# Summer

adjRPSS-JJA TAS 7-MME for NA



GRADS: COLA/IGES

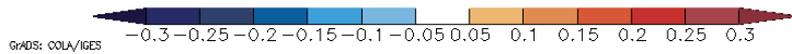
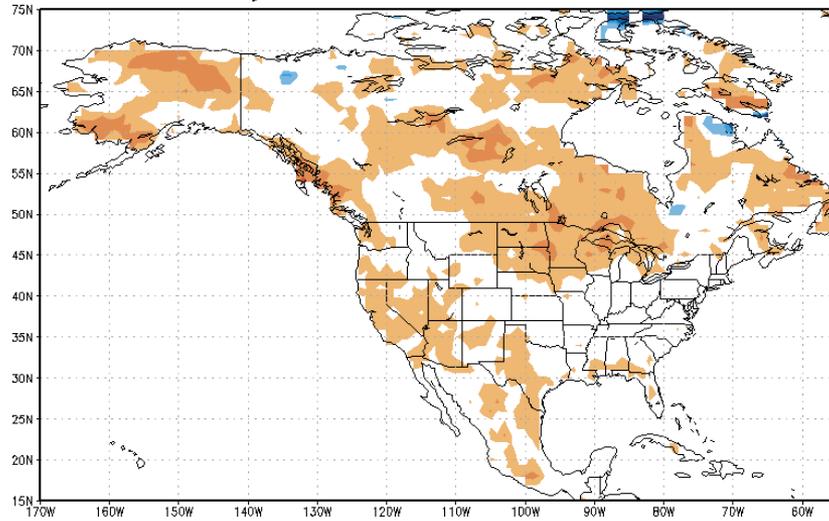
adjRPSS-JJA PR SFC 7-MME for NA



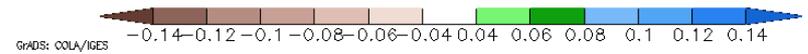
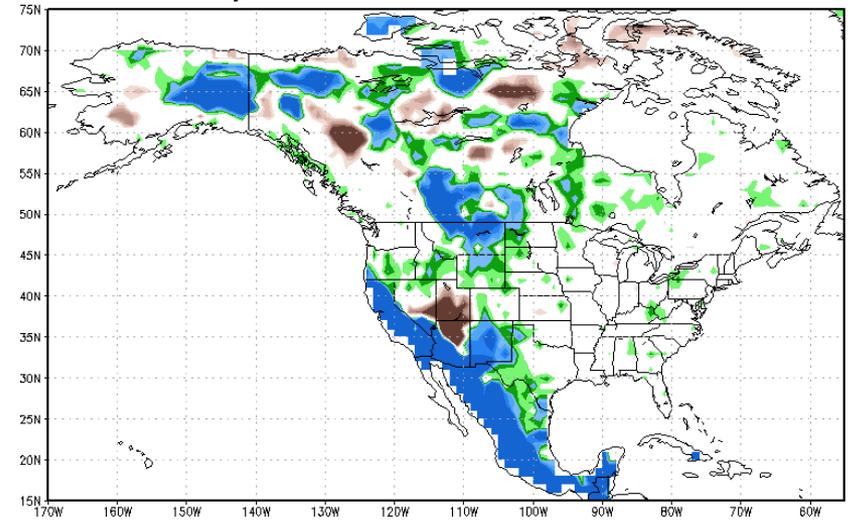
GRADS: COLA/IGES

# Spring

adjRPSS-MAM TAS 7-MME for NA

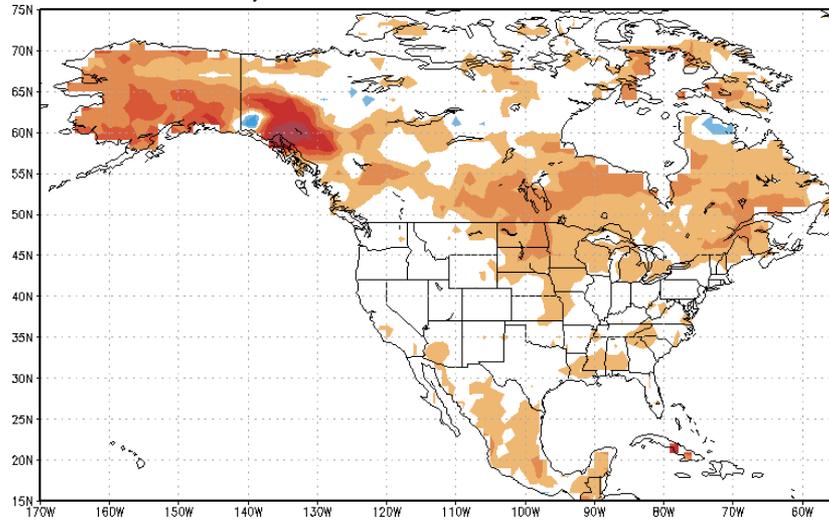


adjRPSS-MAM PR SFC 7-MME for NA

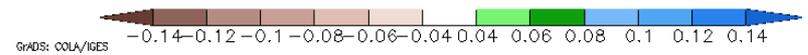
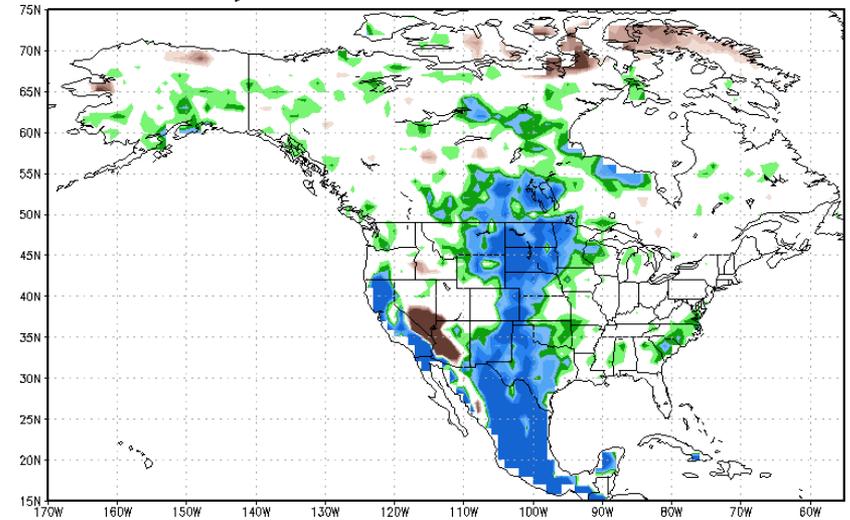


# Fall

adjRPSS-SON TAS 7-MME for NA



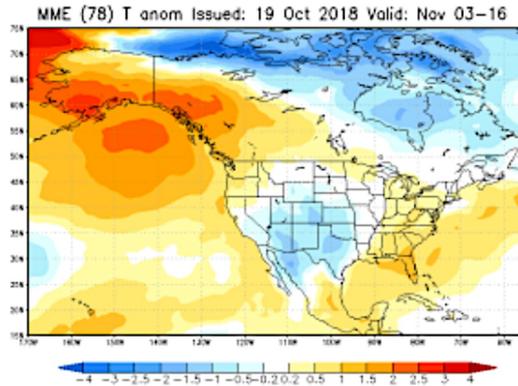
adjRPSS-SON PR SFC 7-MME for NA



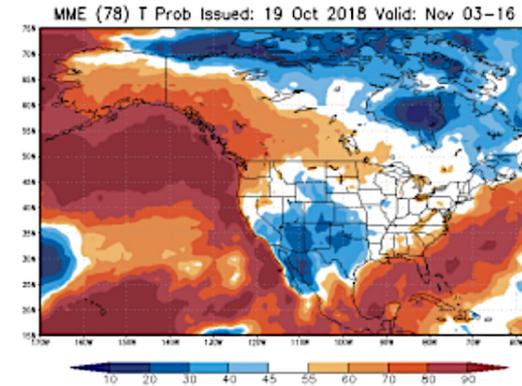
<b>Week of Realtime Dates and Target Dates</b>	Jan 2	Jan 3	Jan 4	Jan 5	Jan 6	Jan 7	Jan 8	Jan 9 Forecast Day	Week 3-4 Outlook: Jan 24 – Feb 06
<b>Day of the week and Days to Target Dates</b>	Fri 22:3 5	Sat 21:3 4	Sun 20:3 3	Mon 19:32	Tues 18:3 1	Wed 17:3 0	Thurs 16:29	Fri 15:28	2 weeks: Sat + 13 days (Fri) → WK34
<b>Center-Model in Realtime **More members, total 78 → different weights</b>									
ECCC-GEM 20 members 32 days								Forecast Day	
EMC-GEFS 21 members 35 days								Forecast Day	
ESRL-FIMv2 4 members 32 days								Forecast Day	
NASA-GEOS 4 members 45 days								Forecast Day	
NCEP-CFSv2 16 members 44 days								Forecast Day	
NRL-NESM 4 lagged members 45 days								Forecast Day	
RSMAS-CCSM4 9 members 45 days								Forecast Day	
<i>Coming Soon:</i> CESM-46LCAM5 10? members 45 days								Forecast Day	
CESM-30LCAM5 10? members 45 days								Forecast Day	

# Produced Weekly: SubX Real-time Temp, Precip, and 500hPa Anomaly and Probability Maps

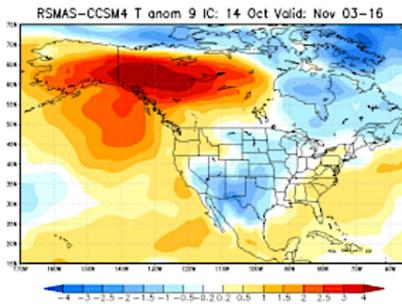
## MME Anomalies



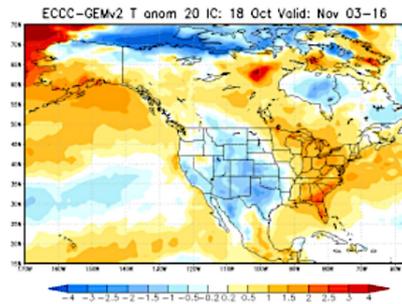
## MME Probabilities



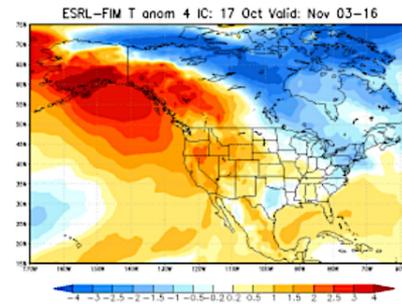
## RSMAS CCSM4 Anom



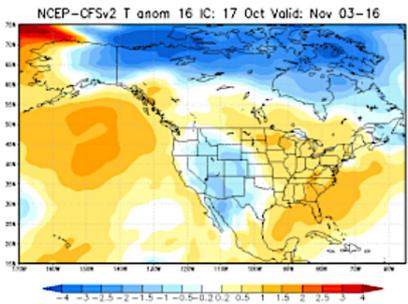
## ECCC Anom



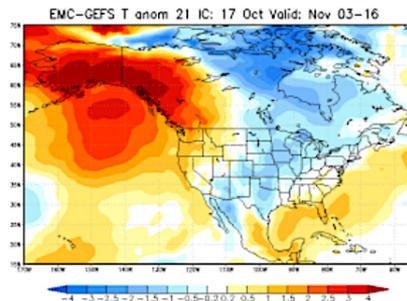
## FIM Anom



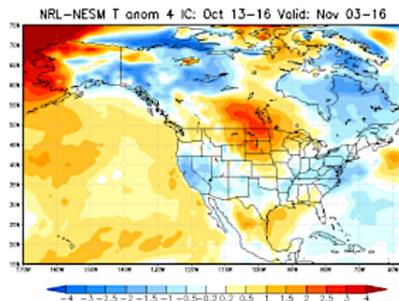
## CFSv2 Anom



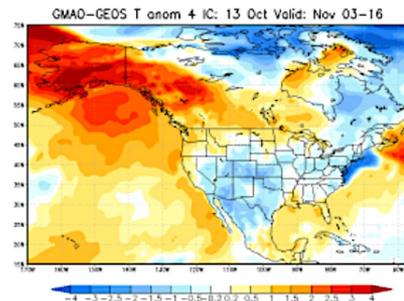
## GEFS Anom



## NESM Anom

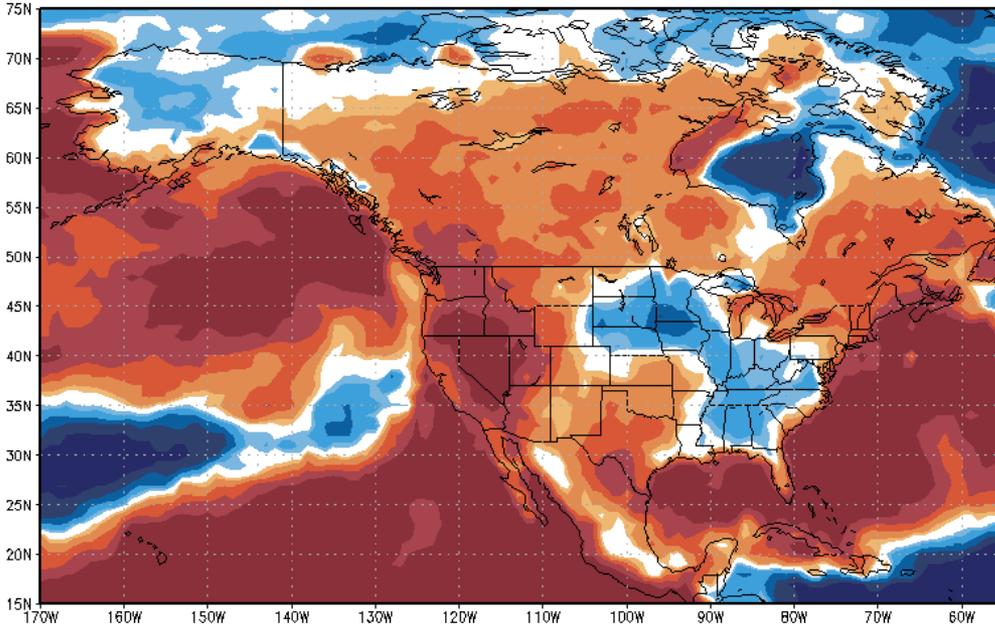


## GEOS Anom

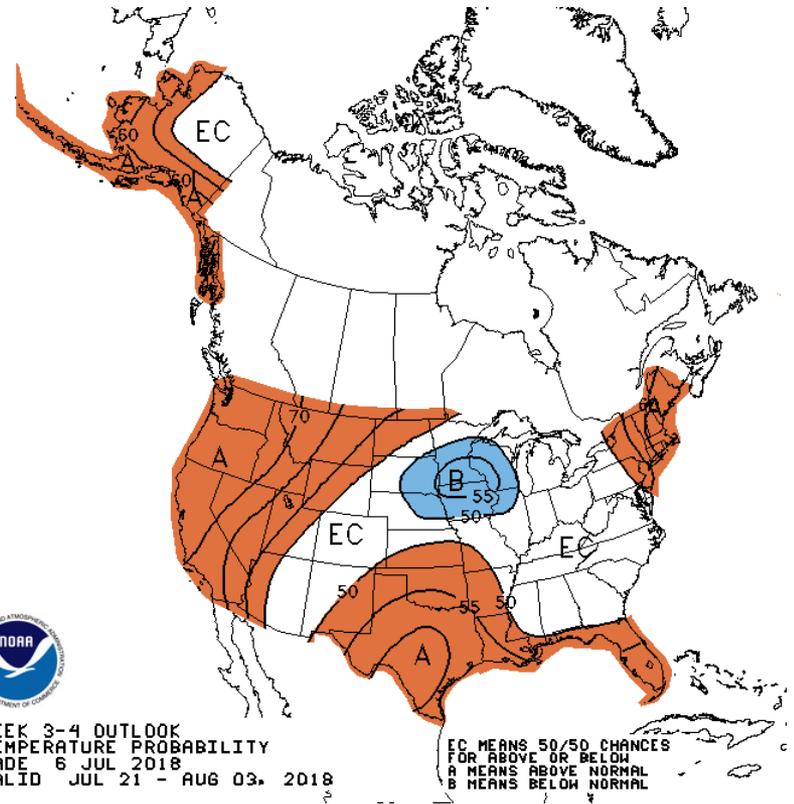


# SubX Real-time Contribution to Official Week 34 Outlook

MME (79) T Prob Issued: 06 Jul 2018 Valid: 21 Jul - 03 Aug



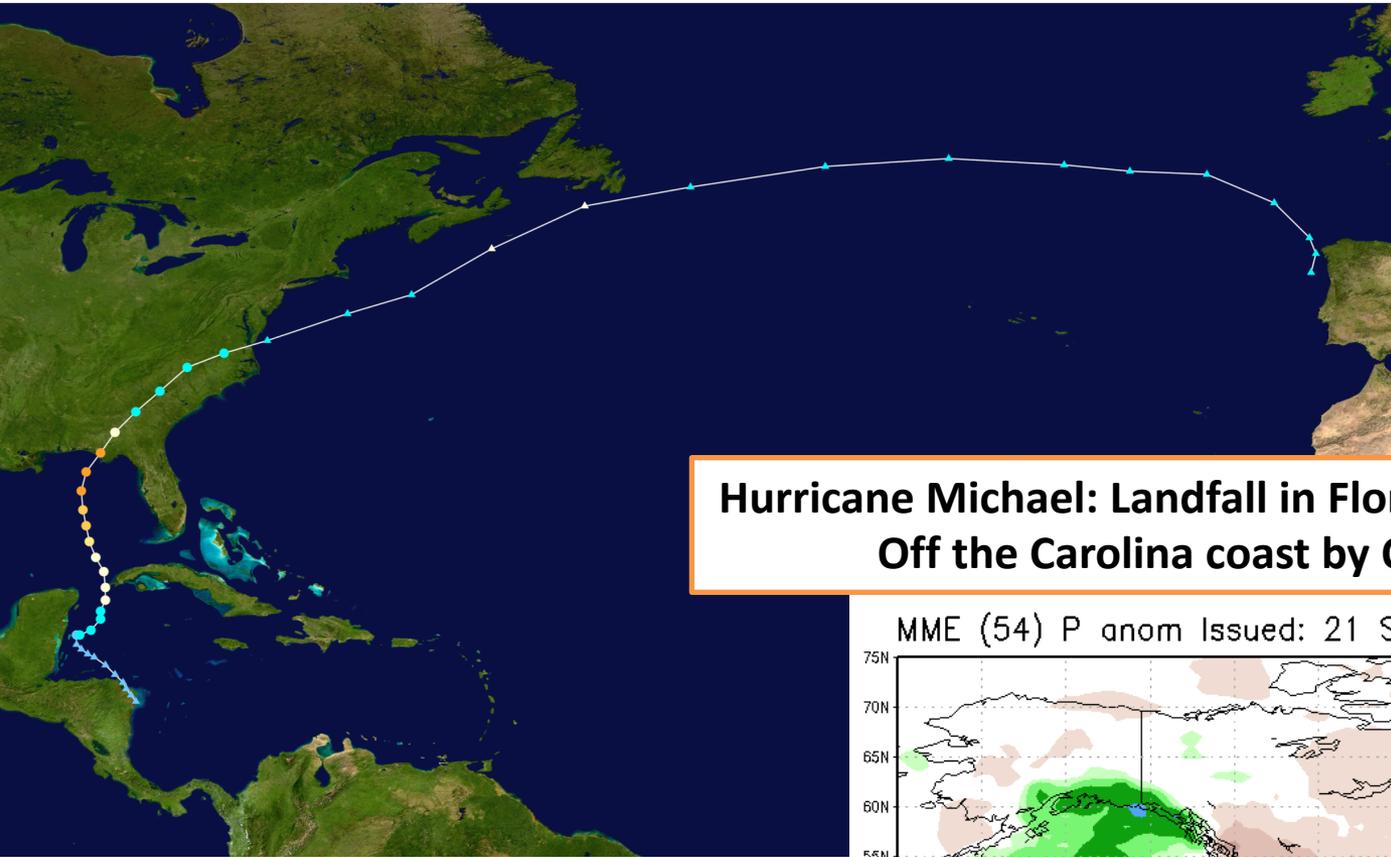
SubX real-time Week 34 probability map



CPC Official Week 34 Outlook

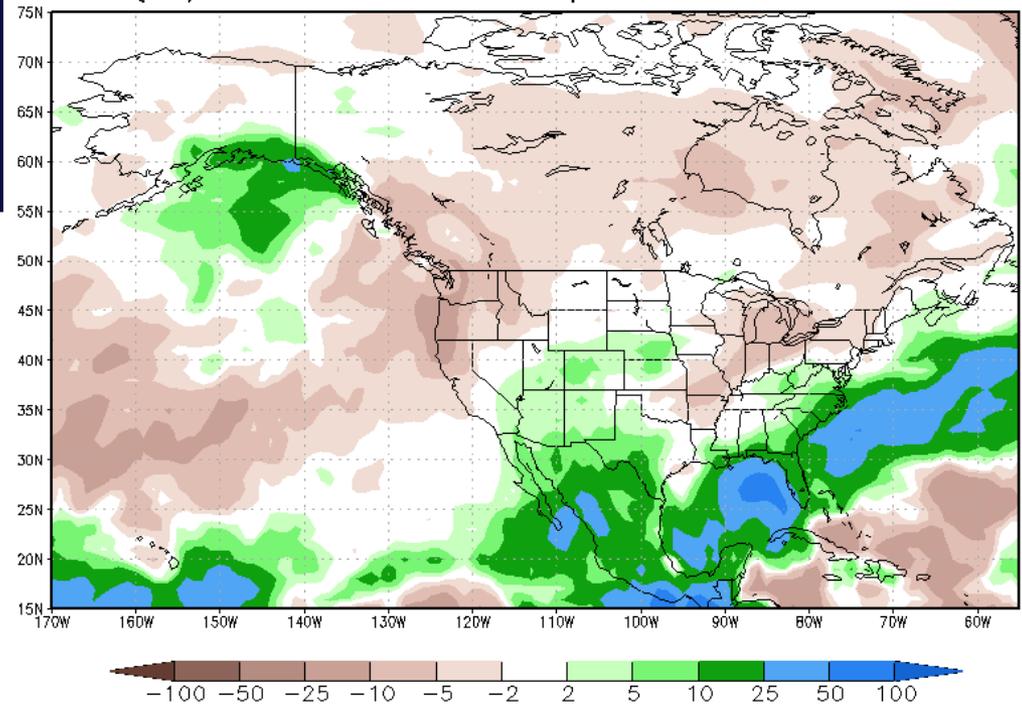
# What's next...

- ✓ Complete hindcast verification – precipitation is in process
- Real-time verification
- Week 3-4 hazards – tropical cyclones from 2017 and 2018 in the SubX...

A satellite-style map showing the path of Hurricane Michael. The path starts in the Gulf of Mexico, moves north along the Florida coast, then northeast along the Carolina coast, and finally curves northward into the Atlantic Ocean. The path is marked with a line of colored dots (orange, yellow, white, cyan, blue) and arrows indicating the direction of travel.

**Hurricane Michael: Landfall in Florida on October 10, 2018  
Off the Carolina coast by October 12, 2018**

MME (54) P anom Issued: 21 Sep 2018 Valid: Oct 06 - 19



# What's next...

- ✓ Complete hindcast verification – precipitation is in process
- Real-time verification
- Week 3-4 hazards
- Value added from the SubX to CPC's operational models
- What else can we do with these data?

*thanks!*